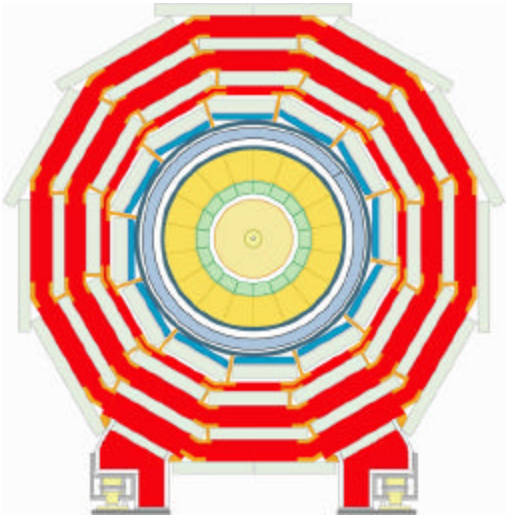
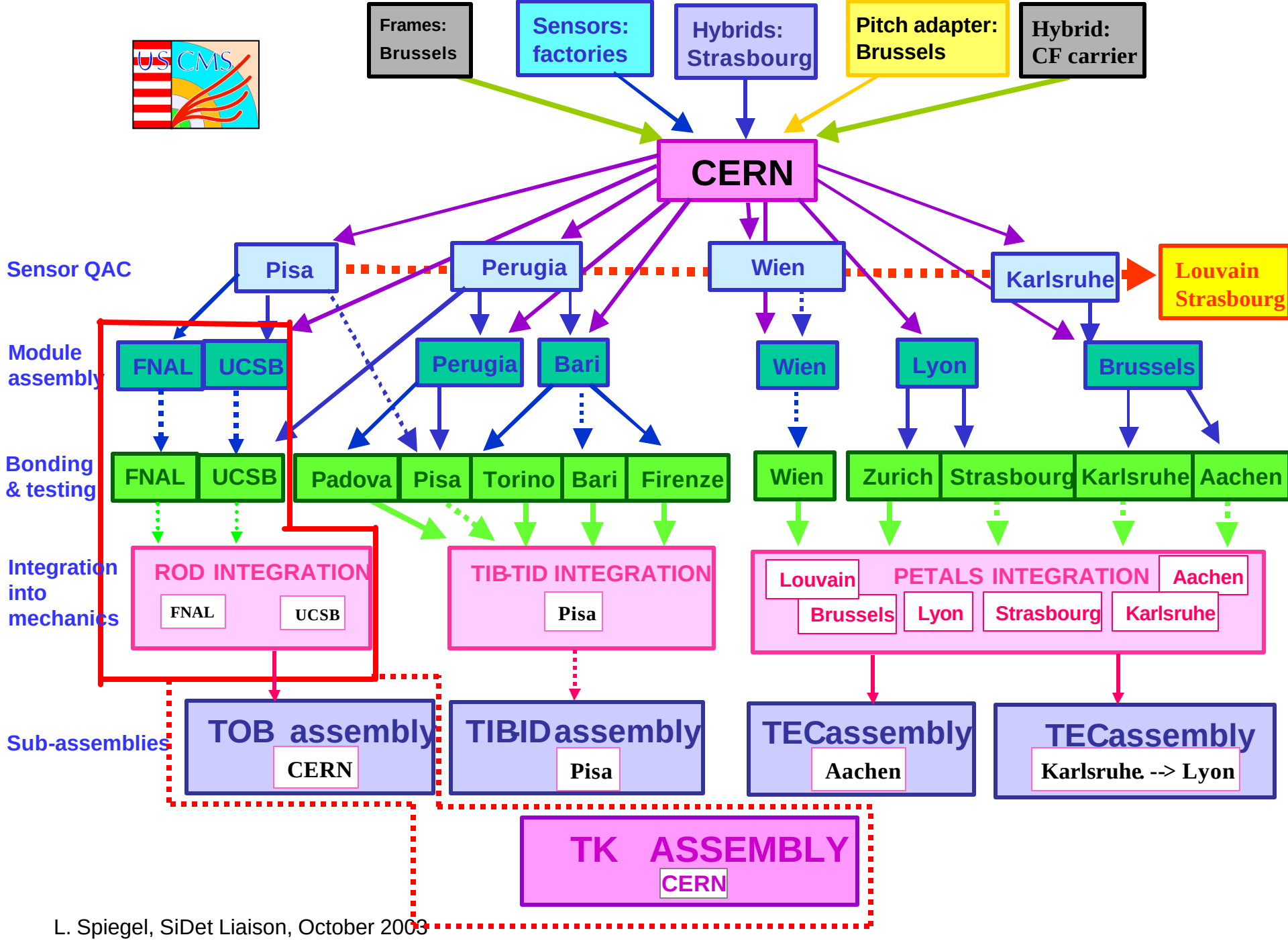


CMS Silicon Strip Module Production at SiDet

L. Spiegel, SiDet Liaison, October 2003


Frames: Brussels
Sensors: factories
Hybrids: Strasbourg
Pitch adapter: Brussels
Hybrid: CF carrier
CERN
Sensor QAC
Pisa
Perugia
Wien
Karlsruhe
Louvain
Strasbourg
Module assembly
FNAL
UCSB
Perugia
Bari
Wien
Lyon
Brussels
Bonding & testing
FNAL
UCSB
Padova
Pisa
Torino
Bari
Firenze
Wien
Zurich
Strasbourg
Karlsruhe
Aachen
Integration into mechanics
ROD INTEGRATION
FNAL
UCSB
TIB-TID INTEGRATION
Pisa
Louvain
PETALS INTEGRATION
Aachen
Brussels
Lyon
Strasbourg
Karlsruhe
Sub-assemblies
TOB assembly
CERN
TIB-TID assembly
Pisa
TEC assembly
Aachen
TEC assembly
Karlsruhe --> Lyon
TK ASSEMBLY
CERN

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P. Baringer, A. Bean, L. Christofek, D. Coppage

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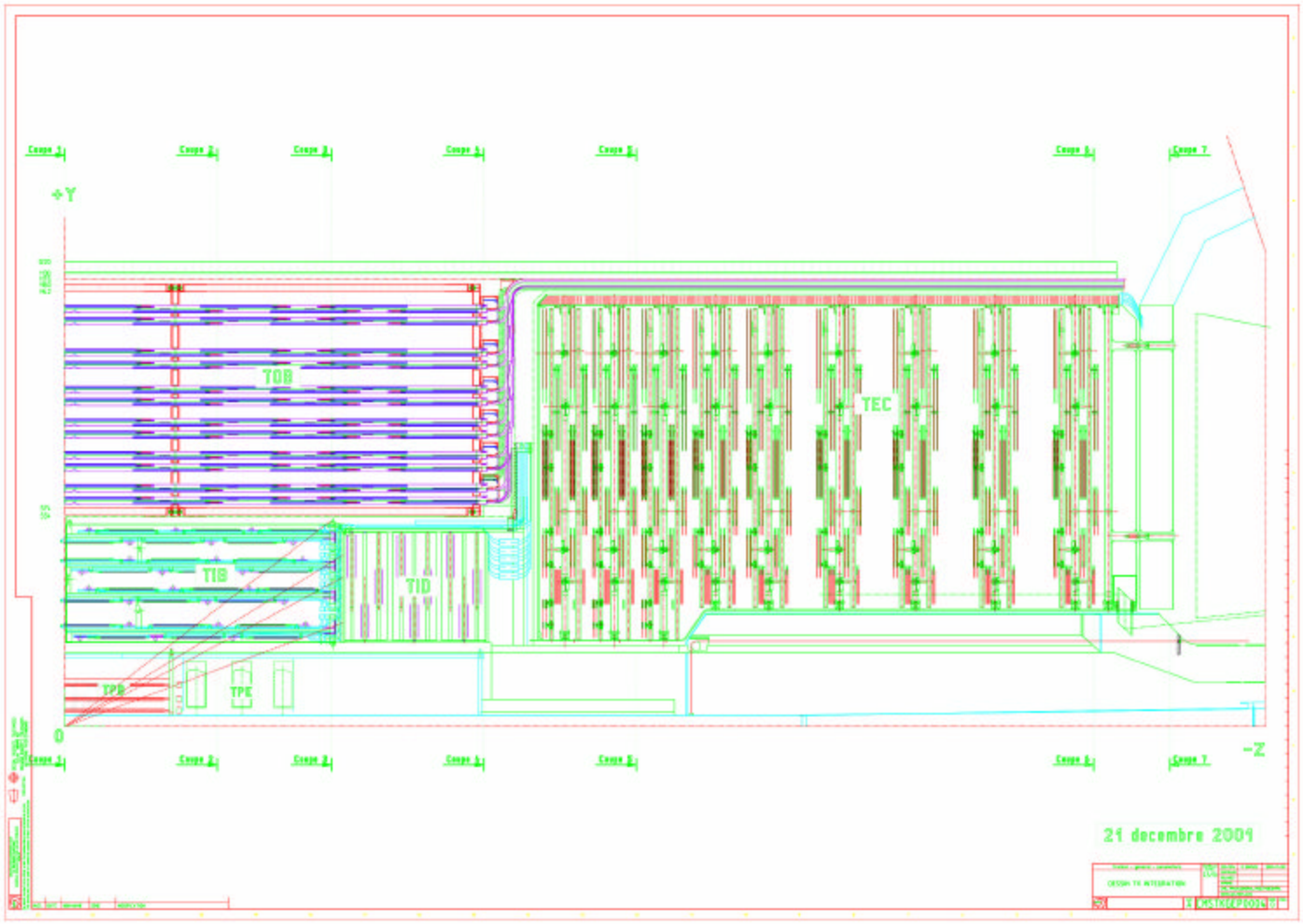
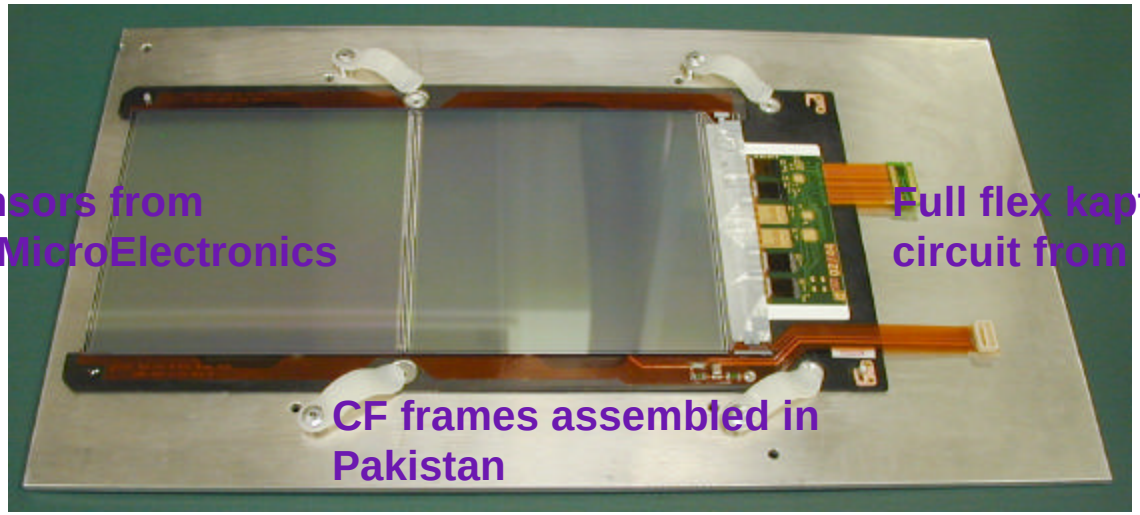
R. Demina, R. Eusebi, E. Halkiadakis, S. Korjenevski, A. Hocker,
P. Tipton

CMS Tracker

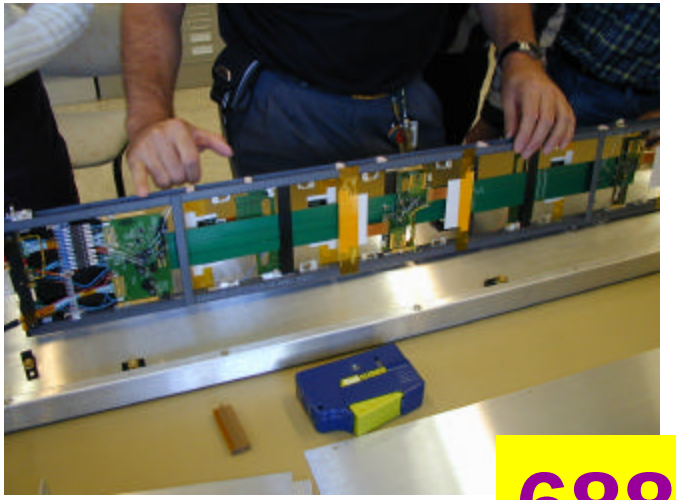


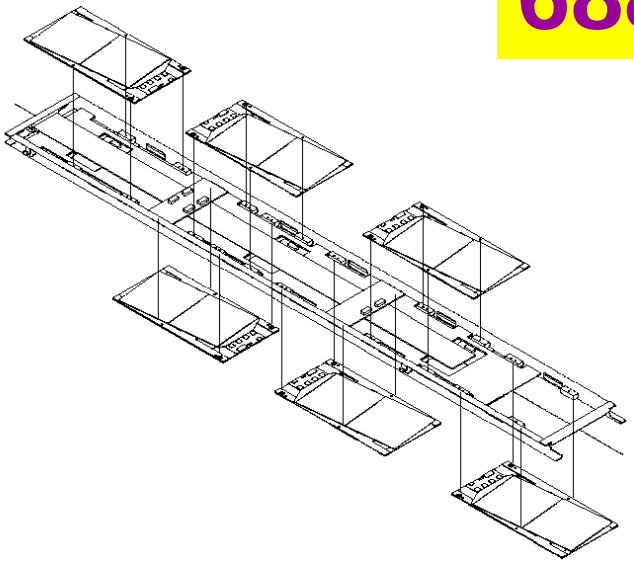
TOB Module Components



- TOB consists of 5,208 two sensor modules (plus 5% spares).
- The first two TOB layers contain 540 stereo modules.
- ST sensors are 500μ thick and come in two pitches: 122μ (6 chip) and 183μ (4chip).

Rods

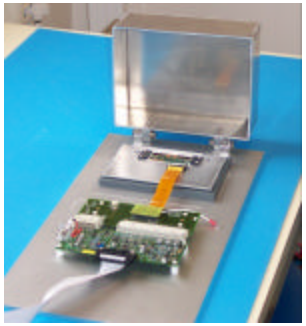




688 rods

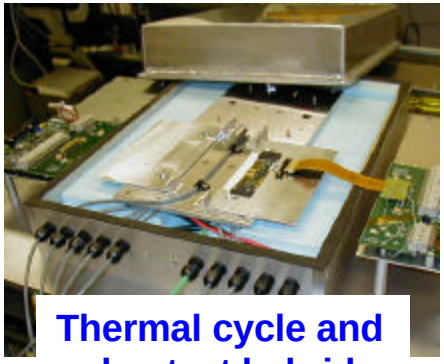
One of two TOB barrels

TOB Production Cycle



Quick test hybrids on ARC

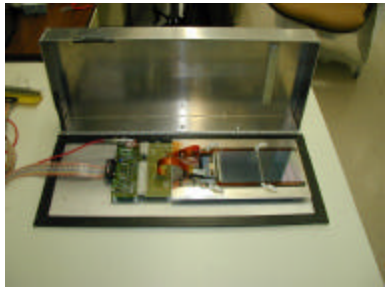
Wire bond



Thermal cycle and pulse-test hybrids

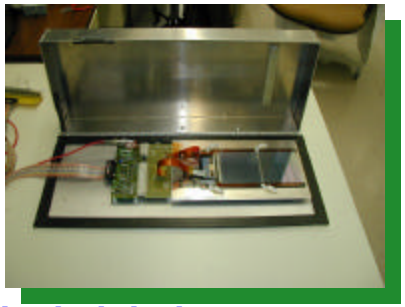
Gantry makes modules.

Wire bond



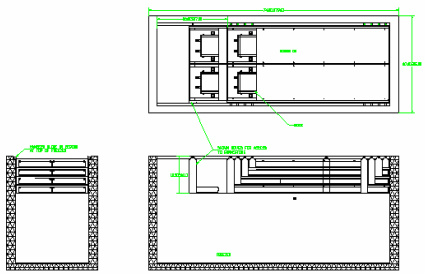
Modules test on ARC

24 hour Thermal cycling



Final pinhole test on ARC

Assemble rods from modules



Rod burn-in

Rods shipped to CERN

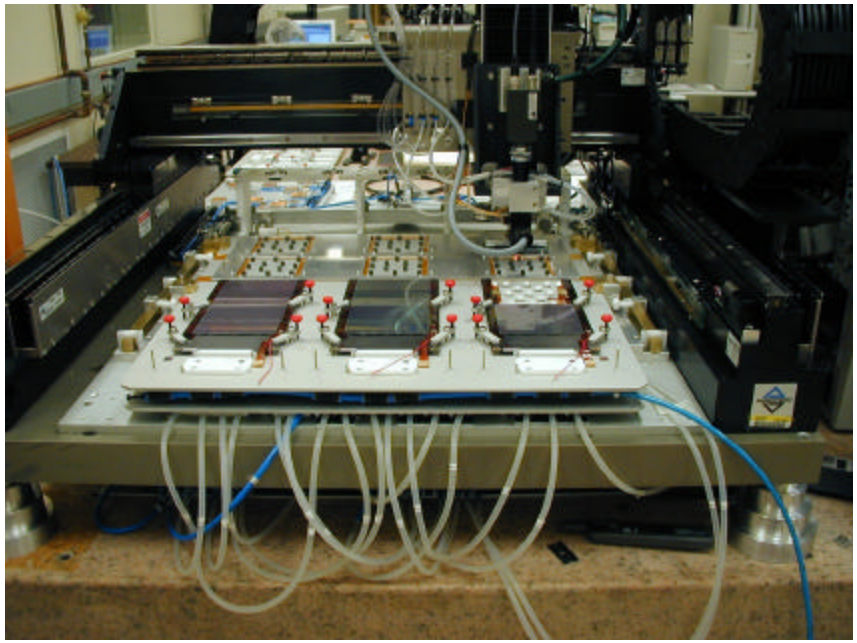
TOB Layers

Layer #	Avg. radius	Modules in phi	Total # of modules	APV / det	Pitch phi	Pitch stereo	Total # of APVs
TOB1	608	42	504	4 + 4	183	183	4032
TOB2	692	48	576	4 + 4	183	183	4608
TOB3	780	54	648	4	183	-	2592
TOB4	868	60	720	4	183	-	2880
TOB5	965	66	792	6	122	-	4752
TOB6	1080	74	888	6	122	-	5328

- FNAL and UCSB have been set up to have roughly equal production capacity.
- UCSB has recently agreed to take over the bonding of TOB hybrids (pitch adapter to APV bonds).
- We are discussing with the Tracker community the possibility of bonding additional hybrids (TEC and TOB) at FNAL and also sharing with UCSB responsibility for some additional TEC modules.

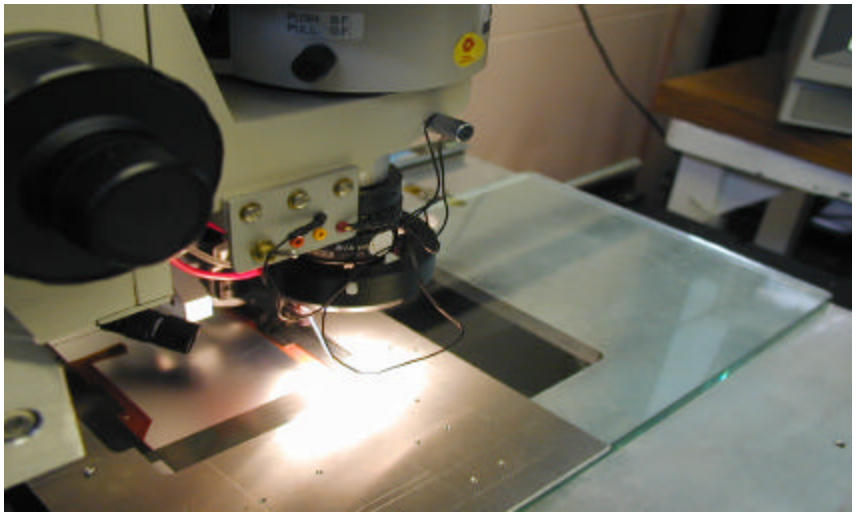
Robotic Assembly

- CMS has mandated the use of robots for module assembly.
  - Provides some uniformity and allows the use of common software (Aerotech MMI and LabVIEW.
  - Gantry centers in Bari, Brussels, CERN, FNAL, Lyon, Perugia, and UCSB.
  - About 1 hour to assembly 3 TOB modules.
- Picture shows FNAL gantry in Lab D clean room.



Aerotech Gantry Robot System

Module Encapsulation



- Module shipping experiences have shown that sensors can flex significantly resulting in broken wire bonds.
- A silicone compound will be applied to the backside of the modules at the seams.
- Above pictures show semi-automated application using a dispensing station in Lab A.

Wire Bonding

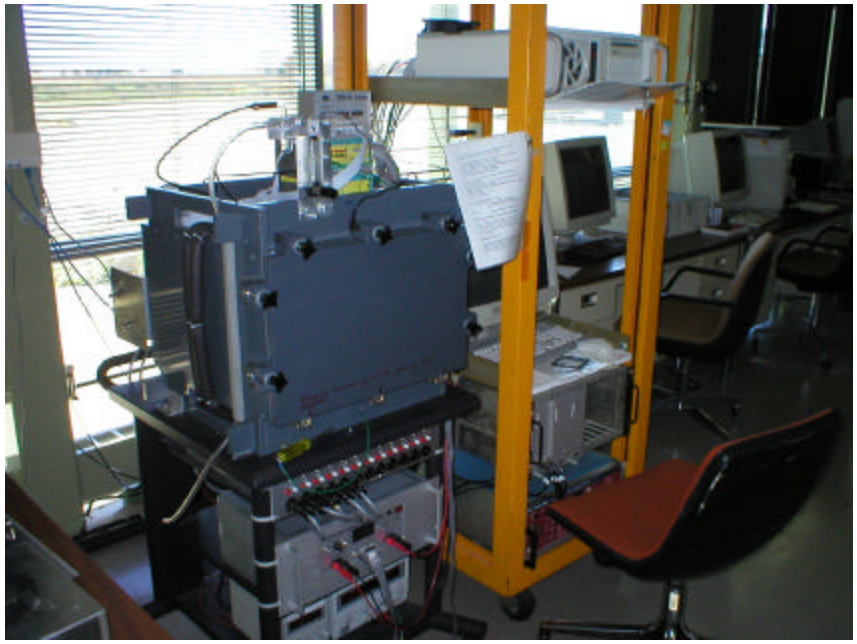
- Each site will need to make over 3 million wire bonds for the TOB modules.
- At peak production will need to bond 9 modules per work day.
- UCSB has agreed to bond all TOB hybrids and FNAL is exploring the possibility of bonding TEC hybrids (or a mixture of the two).

Module ARC Testing

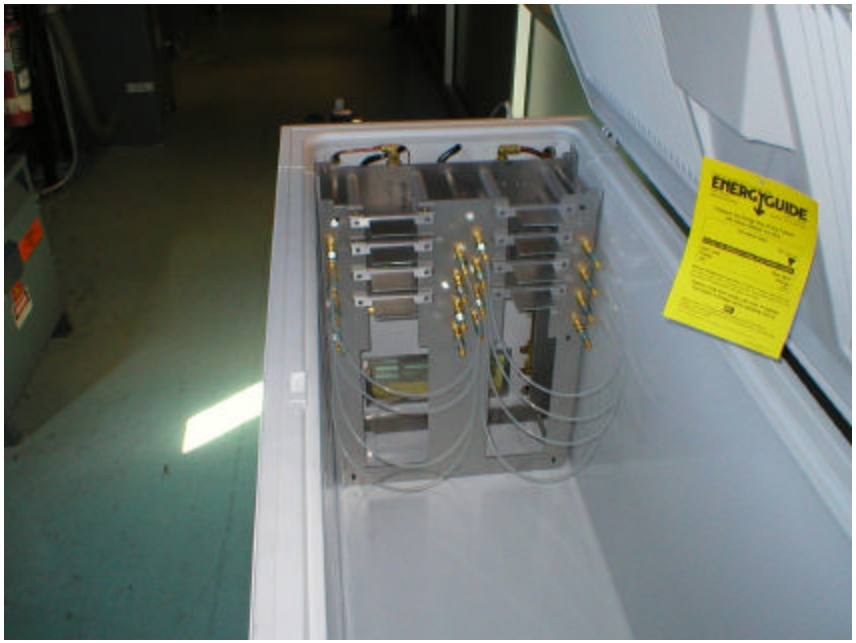
- APV Readout Controller (ARC) systems used for fast testing of hybrids and modules.
- ARC testing at FNAL will take place primarily in the Lab D clean room.
- Testing includes IV measurements, noise measurements, and led illumination of the sensors.

Module Long-Term Testing

- Vienna box holds up to 10 modules.
- Peltier elements used for heating and cooling.
- All modules will be thermal cycled and then re-tested on an ARC system.
- LT system uses CMS DAQ components.
- System will be transferred to Lab C clean room.



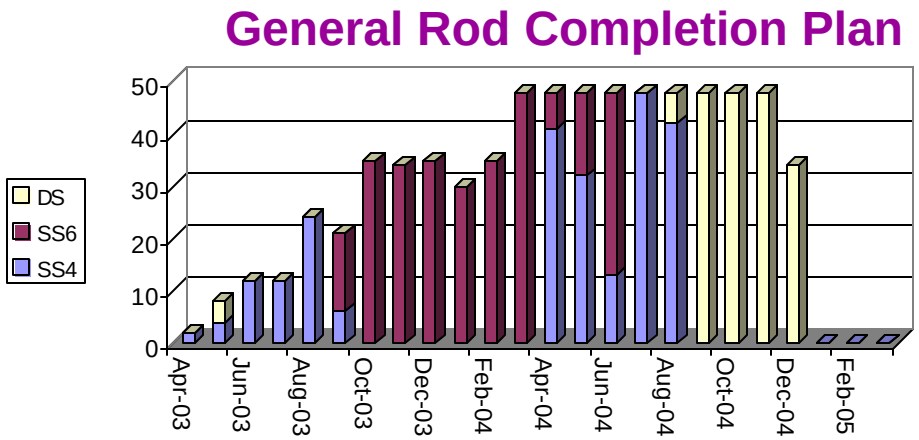
Rod Burn-in



Recently delivered Rochester rod burn-in chest freezer.

- 688 rods will be assembled, tested, and shipped to CERN.
- Each rod consists of 6 (12) axial (stereo) modules.
- Rods will be thermal cycled for 72 hours using CMS DAQ and C_6F_{14} coolant.
- Rod work at FNAL will be done in the Lab C clean room. Waiting on post-RunIIb layout decisions!

Production Profile



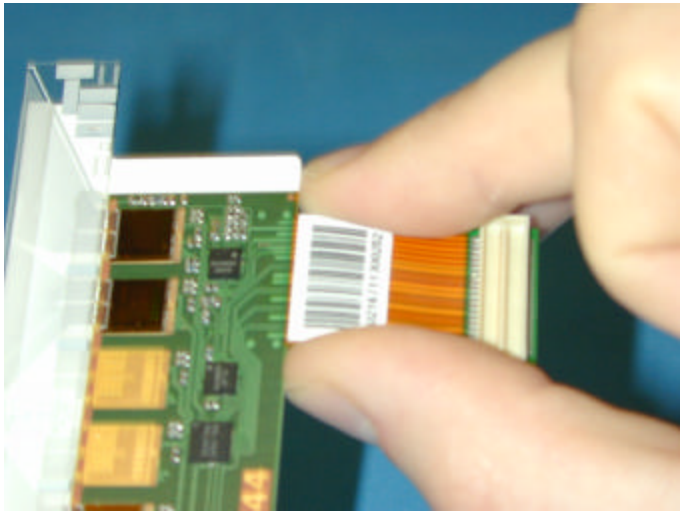
- At peak production we will be building 9 modules per work day at FNAL and UCSB.
  - This implies that hybrid testing, module bonding, module ARC testing, module LT, and rod fast testing and burn-in are all in balance.
- Recently UCSB received the first functional rod.

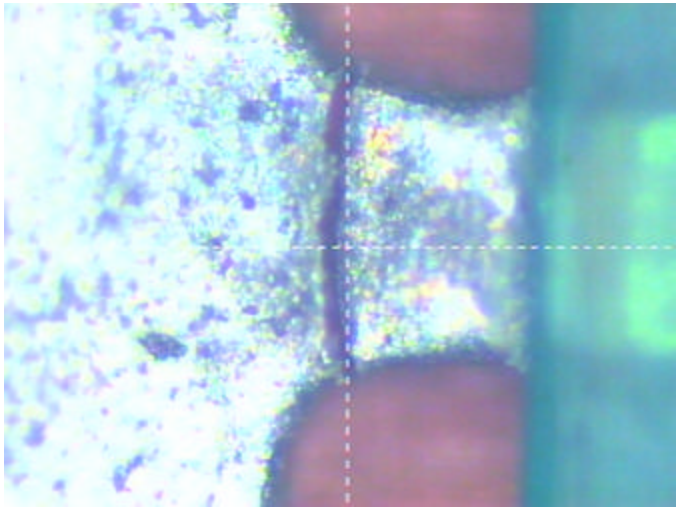
Technical Support at SiDet

- During peak production (=9 TOB modules per work day) the following FTE positions will be required
  - Module assembly (2)
  - Wire bonding (1)
  - Hybrid and module ARC testing (1)
  - Long-Term testing, rod assembly, rod fast testing, rod burn-in (2)
  - Receiving, inspection, database, shipping (1)
  - Module encapsulation (0.5?)
  - Optical inspection (0.1?)
- Of course due to vacations, shutdowns, and other reasons, many people will need to trained for these jobs.
- Additional work – hybrid bonding and TEC module production – would increase the first 3 categories.

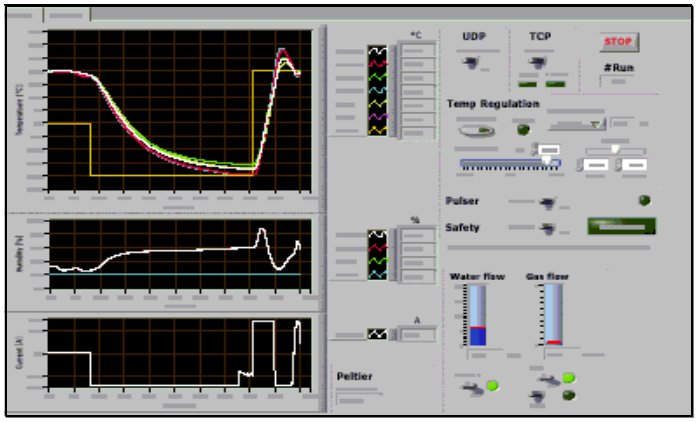
Present Status

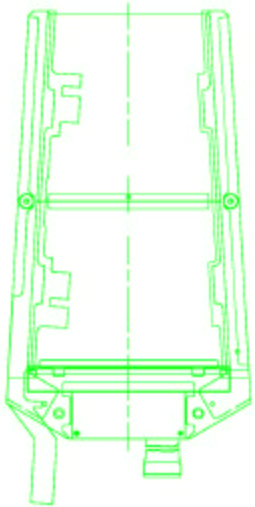
- Both FNAL and UCSB have built about 50 modules and UCSB has recently completed a few stereo modules.
- Module production has been paced by the delivery of hybrids and this has recently experienced a setback due to connector problems.

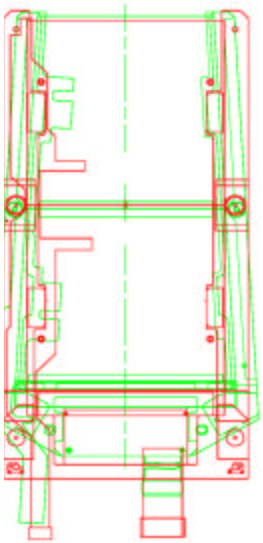




Possible Additional Projects at FNAL







- Bonding ~5,000 TEC (or TOB) hybrids and testing final assemblies
  - One microbonder FTE for about one year.
- TEC rings 6 and 7
  - About 2,000 modules
  - Similar in size to TOB modules
  - Would require a second robot

Both of these projects are presently under discussion.